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ABSTRACT

Outcomes-based education (OBE) is growing in stature in Australia and other Westernized nations. In Australia, education systems have adopted OBE within the framework of National Profiles curriculum statements in eight learning areas, including arts, health and physical education, science, English, languages other than English, mathematics, studies of science and environment, and technology. Schools must assess students' progress against more comprehensive outcomes and engage in evaluation and assessment of teaching in a publicly verifiable manner. The scope of these changes has overwhelmed many educators who do not have access to the most advanced information processing technology. Instructional Management Systems (IMS) utilizing computers are designed to manage many aspects of schooling: curriculum development, instruction, evaluation, and assessment. However, computer technology and its benefits to information flow have been slow to enter the classroom and instruction. A new curriculum model must be adopted that keeps up with and effectively manages emerging and rapidly changing information. Well constructed IMSs allow unobtrusive and automatic acquisition of data in areas of curriculum, pedagogy, and assessment. The IMSeries software provides the information management tools to meet educators' needs. (Contains 15 references.) (JPT)

INFORMATION PROCESSING, OUTCOMES-BASED EDUCATION AND THE MANAGEMENT OF TEACHING AND LEARNING

by

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INFORMATION PROCESSING, OUTCOMES-BASED EDUCATION AND THE MANAGEMENT OF TEACHING AND LEARNING

In the current round of educational reform in Australia, as well as in 'Westernised' societies elsewhere, there is now plentiful evidence accumulating in curriculum policy and related documents that illustrate a trend towards the achievement of prescribed student 'exit outcomes' as a consequence of protracted periods of schooling. Attention to Outcomes-based Education (OBE) has had a rather mixed reception in many parts of the world, but in the Australian States and Territories, notwithstanding some internal tensions attendant to the principle of 'States Rights', education systems have adopted OBE via student exit outcomes 'captured' in National Profiles curriculum statements. Student outcome statements have been framed across eight learning area profiles to include the Arts, Health and Physical Education, Science, English, Languages Other Than English, Mathematics, Studies of Science and Environment and Technology. Student outcome statements have been sequentially developed across eight developmental levels which in turn define a core of essential curriculum elements. An example, drawn from the Technology Profile, is shown in Figure 1.

FIGURE 1 ABOUT HERE

Similarly, in England and Wales OBE is given form through the use of Attainment Targets and Levels as part of the National Curriculum there (Bennett, Wragg, Carre and Carter,1992). In the USA, goal statements, framed in terms of student outcomes, are currently being developed across a range of subject areas.

Outcomes-based Education provides teachers with the framework for planning and monitoring student progress against nationally determined standards for student learning framed in outcome terms.

Therein lies a problem. Among other considerations, The outcome statements embodied in the profiles provide frameworks for monitoring student progress

employing data aggregated across cohort groups related to school priorities. Schools will be responsible for monitoring and recording student progress, establishing priorities and ensuring that programs are put in place that enable students to progress smoothly to the next level of learning. They also provide the basis for a sharper focus in reporting to parents and others with a right to know concerning what students can and cannot do. Given that the main business of schools is to implement and manage a curriculum, it is incumbent on teachers and administrators to meet, and report against, more stringent and comprehensive outcomes for student learning while concurrently engaging in teaching evaluation and assessment in a publicly verifiable manner.

Recent experience with large scale planned change has illustrated, among other things, the swamping effects of extensive information provision which overwhelms those undergoing the processes of change and who are charged with its implementation. This has tended to militate against the implementation of change, rather than promoting it (Carter, 1991). In the flurry of activity associated with contemporary curriculum change, on a global scale, the latent power of new information technology generally does not appear to have been fully exploited for information processing in order to manage curricular operations and change processes on a whole school basis.

The intellectual tools to support instructional leadership through the management of information to guide and inform data-based decision making are already becoming available at affordable prices. Sophisticated Instructional Management Systems (IMS's) which integrate a range of functions that lie at the heart of schooling, such as curriculum development, instruction, evaluation and assessment, engender the formation of information rich environments with enormous transformative potential. A new generation of computer technology, underpinned by pedagogical considerations, can now facilitate the design, development, evolution and alignment of curricula at the macro and micro levels of schooling. They provide, for example, the means for monitoring which curriculum elements are included in daily lesson plans, student grouping practices; 'at risk' students; the development of teacher made learning

materials; the management of material resources; the configuration of assessment programmes across different time spans and subject areas, and curriculum alignment to external references, outcomes, benchmarks and standards on a continuous, routine and substantially unobtrusive basis. Through the total integration of all school functions they represent a marked departure from those Management Information Systems (MIS's) currently used essentially for administrative regulation, underpinned by notions of scientific management and efficiency, and accessible to only a few administrative staff.

Sophisticated IMS technology enables school administrators to determine the curriculum scope and sequence that they desire, while enabling each of their teaching staff to be actively engaged in curriculum development activities in an on-going way. In these environments, curriculum guides become live working documents as educators monitor, adapt and refine curriculum events on a daily basis. For outcome evaluations, supervision and accountability purposes, administrators can ascertain the extent to which a particular teacher uses a variety of instructional activities in his or her teaching, or the extent to which curriculum and its implementation is congruent with state guide-lines, standards and benchmarks, or other external references. Because the IMS automatically records detailed audit trails as staff members use it, supervisors can obtain 'on-line' profiles of how the performance of students and/or teachers are changing, by viewing sets of records accumulated unobtrusively through the daily operations of the school over selected periods of time.

It is evident that this facility raises a number of commensurate issues about the interaction of staff with powerful information technologies and the potential which therefore exists for their abuse. These considerations lie beyond the scope of the present paper, but this is not to devalue their importance, or avoid the notion that education is underpinned by a moral imperative. The dilemmas created, however, lie essentially in the human dimension regarding the use of powerful information processing devices, rather than in the devices per se.

While the rhetoric advocating national curricula abounds, schools seemingly do not yet have the means to implement emergent designs in the stringent manner required in an age of accountability (Carre and Carter, 1990). It is contended that, in the absence of Instructional Management Systems (IMS) technology, and the multi-dimensional views of teaching, learning, curriculum and assessment which are facilitated by their use, adequate monitoring of student outcomes and accuracy in reporting their attainment, or progression thereto, is not likely to be realistically achievable. It is doubtful at best that monitoring a range of student outcome statements and the indicators of their achievement by uniquely endowed individuals, can be done effectively, while similarly attending to all the other requirements of contemporary life in schools and classrooms.

New technologies construct a totally new environment and this radically alters the way we use our senses and thus the way we act and react to things. On this basis, the restructuring that necessarily occurs as a consequence of introducing new technology enters practically every facet of our lives. Changes come, therefore, because of the application of new technologies and it does not matter so much about the details of the content. The inevitable transition to computer-supported learning contexts offers major challenges and new opportunities for pedagogy and curriculum, potentially enabling us to break the lock of structures and the inertia of tradition that we have tended to think of as givens, when introducing changes into our education systems.

The On-line Curriculum

In newly created information rich environments what is needed to effect the shift and break the deadlock of convention and tradition is the vision to reconceptualise the curriculum and the nature of schooling, and the leadership to give effect to the vision. Much of the expenditure of resources in time, money and human endeavour recorded in a voluminous literature has not been noteworthy in bringing about changes of the order required to have a noticeable and durable effect on educational systems and

practices. In spite of this, the history of educational reform is one in which we have persisted with the use of change models and strategies many of which have been shown to be ineffective (Carter, 1993).

Change efforts in the main appear not to have met the needs of complex post-industrial societies nor to have helped very much in improving the quality of life and opportunities for the self-actualisation of large numbers of the population. Creating a curriculum for the next century requires not only thinking about how to do things better, but how to do them differently, in seeking educationally justifiable ends based on a vision of the future or alternative futures that we now hold. The latent power of technology to assist in this process seems to be conspicuously absent in debates about effecting the reform and restructuring of education. Where statements about the nature and role of technology **do** feature in the management of teaching and learning they tend to be focussed on the outcomes of the educational process, rather than being conceived in terms of the process itself. One of the current management problems for Outcomes-based Education, for example, is to link student performance against exit outcome statements with the educational processes that give rise to particular educational results. From this 'over the shoulder' perspective there is an inherent danger that organisational and system structures become determinants of curriculum design when in fact the structures in which a curriculum design is to be made operational are part of the design itself (Carter, 1991; 1993).

The advent of new information technology for the purpose of school administration; the efficient allocation of resources and the management and scheduling of curricula has made life for administrators, paradoxically, more simple yet more complex. At the interface of teaching with learning, the introduction of the microcomputer allied with advances in communications technology provides us with the potential to revolutionise both, as well as the organisational structures in which they conventionally take place. In short the computer, when acting in combination with an informed mind, acts as a

contemporary eolith allowing us to perceive yet further possibilities which were previously not possible.

Mirage or Reality

The potential of the liberating influence due to the arrival of the microcomputer, modem and interactive video disk in freeing the practitioner from classroom drudgery has, for many, yet to be realised. The high tech. classroom is one in which, for example, individualising instruction can become a practical reality, offering students, teachers, supervisors and parents unlimited access to information that would have been unthinkable hardly a generation ago. In this scenario the traditional didactic schoolroom model of education will be even less appropriate than it is now, and yet the research on teaching shows the extent to which this pervasive style of direct teaching is resistive to change. In this regard, Lanier and Little (1986) note:

> For teachers this emphasis (i.e. reflexive conservatism, *sic*) often means a continuation of the teaching practices by which they were taught as well as the tendency to see the prevalent patterns of teaching as the only ones possible. It means a restriction on their views of what they might do as teachers ...
>
> (Lanier and Little, 1986: 551)

Exacerbated by poor resource provision and limited access to hardware, teachers generally appear to be reluctant to use, and hence realise the potential of new information technology in their instruction and management of learning in ways that can enhance their professional effectiveness.

Kelly (1991) notes, with respect to the U.S.A., that the nation's educational systems have been slow to react to changes unless they are forced upon them by external demand factors, and that education seems to be isolated from the sources of innovation that have driven productivity growth. He argues that three things are needed to correct this which are located in :-

1) a source of innovations in teaching and learning strategies,

2) an efficient way to communicate these innovations, and

3) an incentive system that rewards productive innovations and quickly eliminates bad ideas (p.11).

Developments in technology provide the opportunity to improve existing services at the school and system level as well as providing special types of educational services which could exploit the special features of emergent technologies for improvement and change. These are becoming well recognised but still operate in a piecemeal, disjointed and incremental way, rather than functioning in a truly integrative fashion in supporting and managing curriculum, pedagogy and assessment in an information dependent environment - thereby changing it to one that is information rich. The lead time between envisioning the transformation to information rich environments and their realisation in practice, however, is proving to be inordinately long in the area of education which is naturally information oriented and information dependent.

Notwithstanding their limited availability for many, the potential of such tools in education remains just that - potential still waiting to be realised. Herein lies the heart of the problem. Education, as an information oriented endeavour, lacks the infusion of capital and technology on the scale needed to make a significant impact on school improvement, and the enhancement of a wide range of student outcomes which become possible through interacting with new information technologies. The status quo in many of our schools stands in marked contrast to a modern office, in which people following information oriented occupations are supported by massively funded equipment and the necessary support infrastructure to carry out the institution's mission. As a conservative estimate, over two thirds of the secretaries across the USA make routine daily use of a word processor. In stark contrast, and with some notable exceptions, many of our education systems are still characterised by an industrial era mentality, attuned to a mass production factory production line metaphor, in which the people they serve are inadequately provided with the tools for realising their personal and collective potential.

Information management systems are essential, not optional, if we are ever going to move beyond tinkering around the edges of the curriculum and effect changes that engage the deep structures of the schools and/or other learning contexts and structures we may yet determine, and that impacts upon the manner and form of their functioning in a systematic and integrative manner. At this juncture the alternative to doing this is to continue to follow fads, 'top-down' mandates which seldom impact on classroom practice and adhere to old ways of doing things under the guise of new labels.

While reforms in the school system for many have not occurred on a sufficiently grand scale to register any dramatic impact on what actually goes on in classrooms, some promising long-range technology infusions and innovations have been initiated in pockets in a number of districts and schools. At a national level, however, it has become necessary to seek ways to develop what over a decade ago Toffler (1980) then identified as two basic raw materials for the coming age: information and imagination. The basic skills of reading, writing computing and communicating with all forms of technology are still necessary, but a more systematic effort must be made to get beyond the fashionable rhetoric of higher order thinking and problem solving to make these a reality in classrooms (Carter, 1990). To be functional in a complex participatory democracy students will need to have acquired more than a discrete thesaurus of unrelated facts.

In Western societies at least, the rhetoric exists in abundance supporting the advent of national curricula, for example, but schools, even if they go along with it, do not have the means to implement emergent designs in the stringent manner required in an age of accountability. Those responsible for developing high level thinking skills and attributes in students require the tools to allow them to plan, implement and monitor attendant teaching and learning processes, including their effectiveness and consequences. In addition to managing learning with a process orientation emphasising heuristics, problem finding and problem solving, valuing and evaluating, teachers need to help their students acquire a more sophisticated understanding of social structures as these apply to the economy and work place. A critical understanding of and

commitment to their culture, viewed dynamically, that empowers individuals to transform it at the same time it is being transmitted to them, is nowadays both a high order life-skill and an imperative for the reconstruction of society as we envisage it now and would like it to become (Lawton, 1992: 121).

Learning also has to become more integrated across subject areas and we need to get a 'whole curriculum' perspective on the vertical and horizontal integration of curriculum elements, and the monitoring of student transitions in a hurry. We now have, among other things, the tools available to resolve the hitherto intractable problem of curriculum correlation, and vertical sequences from initial entry to school, and the capacity to monitor students longitudinally across transitions in the education system and on exiting formal schooling. In the absence of such tools conceptions such as these tend to remain interesting theoretical concepts embedded in scholarly texts and papers which tend not to see the light of day in the social realities of schools and schooling, serving to perpetuate the myth of 'the secret garden of the curriculum', and the gulf between practice and theory.

A Curriculum Model for Information Management.

Traditional curriculum models, if they worked at all in guiding practice, did not take into account one of the major realities of life painfully evident to those who administer, study and teach in schools in contemporary educational environments. It is the generation, flow and management of information that in the past has substantially acted as a bottleneck to, rather than enhancing the implementation of, innovations and curriculum for school improvement and the raising of school achievement in line with individual entitlements and societal expectations.

Several indicators suggest that information overload is likely to be a health hazard to those who manage and populate schools now and in the future (Zanetic, Clarke & Mansfield, 1990) Diagnosis and treatment **requires** the application of new information technology to bring this back to manageable and human proportions, so

that inter alia teachers and administrators may retain more of a sense of control over the processes of change which seemingly envelop them. The basis for conceptualising and integrating emergent curricula with both their internal and external environments lies in, and increasingly must rely on, information management to guide and inform design and implementation decisions made in the light of increasing social complexity and public policy agendas.

In the model presented below the connections between curriculum elements is not a set of generic and implied relationships, but rather one of information flow connecting the elements to each other and the wider environment within which schools are embedded. The relationships are shown in Figure 2.

FIGURE 2 ABOUT HERE

Curriculum

The model is underpinned by a particular ideology regarding the nature of curriculum, pedagogy and the current organisational structures of schooling, but is not context bound by them. The curriculum in its entirety is regarded as a social intervention which schools administer on behalf of society, and which has a moral dimension requiring the legitimate access to information by different members of different audiences regarding its design, implementation and effectiveness. Given the inherent complexity of revisionary knowledge, and the need to develop certain types of skills and higher order thinking processes, a relevant curriculum for today's world requires updating and maintenance on a continual basis. The curriculum review conducted by subject area returning to each after a number of years, for example, is at best unlikely to meet the needs of tomorrow's schools as the lead time between the generation of new knowledge and its application steadily decreases. At worst it is likely to be

continuously redundant if it is allowed to operate on a protracted timeline before revisions are undertaken.

Further, the dynamic nature of the curriculum is not simply two dimensional in its scope and sequence, except perhaps in its latent form. The manifest curriculum is multi dimensional and thus two dimensional models appearing in a range of curriculum documents do not, and cannot, adequately represent the dynamic nature of learning contexts, curriculum processes and attendant knowledge structures. For optimal responsiveness to the latter and the needs of their communities, the curriculum of each school necessitates that it be locally crafted in order to capitalise on local talents, with local insights in order to meet local needs.

Alignment

At the macro level, society has legitimate expectations from its schools as a socio-cultural form. It gives expression to these through a range of agencies, professional organisations and institutional constraints and obligations, backed by mandates, that individually and collectively set standards and external references which the schools are constrained to address. This is acknowledged within the model, which incorporates provisions for the alignment of curricula at the school level with external cross-references or benchmarks. These may be framed as syllabus statements, needs, standardised tests, public examinations and a range of outcome statements at different levels of specificity (see also Figure 3). There are likely to be many relationships between curriculum and external standards and outcomes, however, but all of the relationships are not important all of the time.

Within the model, standards and outcomes are deemed to transcend locally developed curricular structures, content and instruction. Hence there is a need to contemplate the former on the part of those who develop school level curriculum; assess student performance against its outcomes and external references; use this data as feedback to learners and evaluate their effectiveness. Where the external references and standards appear as published documents, the reality is that they are rarely contemplated when

developing and examining the web of relationships existing between curriculum, pedagogy and assessment. Where they appear on-line and can be readily retrieved there are immense benefits to be gained in curriculum alignment. As alluded to previously, there exists a need to articulate purpose or intention with delivery and that is what gives meaning to outcome based education.

Pedagogy

An underlying assumption of the model is that teaching makes a difference, and for the full potential of this to be realised in practice, teachers must be able to capitalise on new knowledge, exercise data-based professional judgements, and acquire intimate knowledge of the changing needs of the learner in the exercise of their own creativity and spontaneity.

Within the dynamics of the model it is important not to seek to control all the activities that take place under the rubric of teaching, but to be able to ascertain its nature at will, and to direct it differentially to learners as needed and in the full knowledge of the extent to which external agencies are also influencing and guiding instructional processes.

Assessment

The functions of those forms of assessment that are learning centred and those which are essentially for the purposes of accountability, credentialing and reporting need to be held separate. Both dimensions imply different sets of relationships with teachers and learners and learners with each other. A more accurate and useful set of performance points for the enhancement of teaching and learning processes are more likely to be achieved by reducing the emphasis on a few highly precise measurements and by increasing the value of many varied and less precise measurements - along the lines of the U.K. experience with profiling and records of achievement, for example. For the increased effectiveness of these processes, student progress needs to be interpreted via professional judgements together with samples of student work, with both formalised and informal assessments gathered over time.

By the same token, mastery is likely to be more validly inferred via patterns of performance over time and in various contexts than from single events isomorphically related to narrowly conceived outcome statements such as performance objectives. Assessment data itself can feed back, in an evaluative sense, to further inform planning, and organisational decisions.

Validation

Whilst the model implies the school and its community are central to the set of relationships between curriculum, pedagogy and assessment that apply in a given context, these cannot be 'self-referent' and especially so with respect to validity. Business, commerce and industry, other institutions, prospective students and their parents and representatives of 'the system' have a public right to know about the school, its programs and performance. This needs, therefore, to be monitored accurately and comprehensively and information feedback loops established for this purpose between schools and organisations in their external environment. Responsiveness of the curriculum to these demands necessitates the broad involvement of all those who teach and assess within it.

The management, control and directing of information is the glue that binds the various elements of the model together. This is needed for reporting purposes and to guide and inform decision making that takes place within and across the institutional environments pertinent to the separate elements of the model, as well as in the micro environment of the school and the macro environment of society. A final element is the need to conduct frequent analyses of data accumulated through self-monitoring of information flow and attendant decision making represented by the inner circle in Figure 2.

The model is dynamic with data accumulating unobtrusively through the normal operation of the school and the processes of education conducted over time. Accumulated data on the functions and operations of the school from a curriculum

development, lesson planning, student, parent and teacher, and assessment dimensions cross referenced to external frames can now be managed with an IMS. Relational data base technology makes data readily accessible to guide and inform decision making serving a variety of needs and purposes. The upper limit of accessing these data in a variety of forms rests with the ability of the teacher, administrator, parent, school nurse, aide, school psychologist and student to interrogate the database in order to elicit the accumulated information they are seeking in a form they require.

Archived data ordinarily lost to the school and the system as 'noise', but now unobtrusively and continuously accumulated through the normal operation of school routines can be queried, probed and structured in ways that support and enable disciplined inquiry into the operation and functioning of the school, including its intellectual, social, economic and organisational aspects as a form of problem finding, and problem solving. Obvious uses here, for example, are for the management and utilisation of the schools' material resources, the conduct of program evaluations and audit trails, supervision of beginning teachers and the induction of new staff, performance appraisal (where access to on-going data can readily support formative processes) and the tracking of 'at risk' students. Research here implies increasing the sensitivity of organisations that can learn, populated by professionals in the service of their clients who are in a real sense students of their own professional practice. In this regard Sarason (1990) makes an observation to the effect that if teachers as learners do not perceive that the appropriate conditions for their own growth obtain, they cannot create and sustain them for students.

To make the model operational the human dimension has to be complemented with new information technology for the purpose of information management. There are two ways of using technology to achieve these ends (1). One is for the purpose of **automating:** the other for **informating**. While there are some who clearly seek to use technology for the former purpose, it tends to become mechanistic and to isolate the human dimension from the process itself. It is not advocated as a satisfactory

means for supporting educators and as a means of educational problem solving. To informate is to empower professionals within this ideal. It is here that 'management sits down with workers' to use an industrial analogy, in order to resolve the question of what information has to be readily available and easily accessible to both understand and execute certain processes. From this stand-point the technology ought to be useful in helping teachers and administrators give effect to this requirement.

School Improvement and Information Management

The history of educational reform shows that planned change tends to be imposed from the top down and managed by the imposition of regulations and mandates that increase the monitoring and reporting requirements of local schools, (Carter & Hacker 1988, Lawton 1992). School administrators tend to comply with increased regulations by adopting technical solutions, which, for the sake of better reporting and monitoring, constrain their schools and systems leading to increased uniformity, thereby reducing the development of the full potential of students and staff. The 'lock' of such systems may be useful in helping to establish and maintain "well run" schools from month to month and year by year, but this is largely at the cost of inhibiting creativity, local diversity and productivity on the part of all those who populate the nation's schools.

Well constructed IMS's are designed specifically to allow for the unobtrusive and automatic acquisition of data describing the key operations associated with the interlocking cycle of relationships between curriculum, pedagogy and assessment (Hextall, 1988). These sorts of data are crucial to determining program effectiveness and can serve to guide school improvement processes. In the absence of comprehensive IMS's, used to collect information and provide a facility for the conduct of comprehensive data analyses, it becomes virtually impossible for educators to simultaneously meet accountability requirements and be effective in the exercise of leadership in the transformation of schools. Accountability, in the sense of being able to define precisely and show relationships between system variables and desired outcomes, proves to be an important but elusive task without recourse to technology

to meet the increased societal expectations of schools and 'valuc for money' for the educational resources expended.

New forms of decision making are needed, based on the acquisition and contemplation of timely data. In the past, the mark of a good principal, for example, was based on the extent to which s/he made decisions using limited information and substantially getting them 'right' more often than not. IMS data provides access to the requisite information relevant to a situation or problem. It thus allows for those decision alternatives affecting a particular situation or problem to be contemplated and the consequences of these to be more readily perceived. Timely information can thus be made available through different levels of accessibility to students, parents, teachers and administrators in the exercise of information rich and data based decision making.

Given the complexity of educational environments in an age of public accountability, it is difficult to comprehend how student performance and the overall achievement of outcomes individually and in the aggregate can be monitored and supported adequately without access to relevant data - yet emerging curricula require just this (Bennett *et al.*; 1992). In order to obtain data on curriculum, pedagogy and/or assessment, they must be gathered thoroughly, automatically and unobtrusively to ensure that they accurately represent what is being implemented. In an era where powerful computing systems are well within the reach of most budgets, and a nationally oriented Outcomes-based Education environment is being established, an imperative is presented to us to acquire and implement, wholescale, IMS's with the transformative potential described above if we are ever to transcend reflexive conservatism (Lortie, 1975: 232) and realise new possibilities for the conduct of instruction and learning.

Before describing the components of a particular Instructional Management System as an exemplar - called IMS Series^{tm} - a number of assumptions underlying its use are made explicit below.

Basic assumptions underlying IMS use.

- Teachers and teacher supervisors are primarily professionals, not technicians.

- Technology should be designed to meet people where they are while enabling them to do things that could not be done without it.

- Technology should not 'drive' nor 'define' change. Rather, it should provide information about and support for change.

- Educational reform doesn't occur unless it occurs in the environment and at the levels at which the practitioners work.

- Information is a major key to educational reform. Practitioners' inability to access, manage, and interpret information is a bottleneck which inhibits reform.

- Data which are important to inform practice must be unobtrusively, automatically, and continually gathered as the processes (which they are to inform) are being conducted.

- Technology must not replace human intelligence and decision-making. Rather, it should enhance both.

An Example of Curriculum and Instructional Management Software.

IMSeries^{tm} software consists of a set of powerful information management tools for educators and is among the first of a new generation of instructional management systems. In one integrated set of tools it enables educators to manage critical information at each stage of the entire instructional and curriculum design process.

IMS Series^{tm} is designed to provide educators with a powerful set of information tools that they can use to:

- capitalise on their training, skills and experience as they plan, deliver, and assess instruction;

- co-ordinate planning and assessment with colleagues and share ideas and expertise;

- determine, improve and manage the quality of instructional processes, and outcomes;

- build longitudinal databases which can serve as references for research on instructional effectiveness and for program development (for both curriculum and staff);

- increase the flexibility of instructional programs by enabling educators to manage complex data;

- track performance of any student over time against any curricular or instructional reference point;

- respond to accountability concerns without giving up professional abilities, the need to make flexible decisions, or the desire to be creative; and,

- allow all those who have vested interests in the quality of instructional programmes to participate in, and review information associated with those programs.

A brief description of each of the four modules that comprise the IMSeries^{tm} software package follows.

Curriculum Developer (CD)

In the USA educators are using CD to design, review, analyse, align, maintain, and generate reports concerning their curriculum. Once curricula are built, educators can align them dynamically to any combination of external standards (e.g. state guide-lines, outcome statements, or standards from professional organisations). With CD, teachers and administrators can view their curricula from an unlimited number of perspectives, because analyses can be performed across any boundaries that may exist in its structure. The underlying curriculum structure is delineated in Figure 3 below.

FIGURE 3 ABOUT HERE

Powerful tools exist to help practitioners rearrange and update curricula. Use of these tools can encourage restructuring curricula into innovative formats. Even though extensive power remains in the hands of the coordinator to determine the scope, sequence, structure, and philosophy around which the curricula are built, CD enables practitioners to align their curriculum with external standards for accountability, quality control, and auditing functions.

Lesson Planner (LP)

Teachers can use LP to manage the massive amounts of information that they need to be able to access and manipulate to design and deliver the high quality instruction that effective educators have always struggled to provide. They can also use LP to assess the results of their decisions; a necessity for any profession. When LP is installed in a network environment, teachers can share information with each other and select from, or extend, curriculum options that are available to other teachers and their students. With LP, teachers can plan and monitor instruction on a class, subgroup, or individual learner basis. Questions about what has been taught, including to which students, how, when, and how often, can be ascertained and analysed at any time. LP also enables teachers to flexibly assess, manage, analyse, and report student performance.

Performance can be analysed and reported by averages, performance profiles, and through electronic portfolios.

Student Data Manager (SDM)

Student Data Manager enables teachers to integrate extensive demographic, attendance, and discipline reporting, accounting, and analysis with instructional planning, delivery, and performance. By this means performance is monitored ecologically and not removed from the context of teaching and learning and other aspects of concern to the processes of feedback and counselling.

Educational Researcher (ER)

Educational Researcher serves as a set of tools which educators can use to examine complex data sets that are generated continuously and unobtrusively as IMSeries^{tm} software is being used. ER is intended to be useful as a means of helping practitioners and researchers determine what is or is not working, and how well or poorly. In addition it serves as a research tool to help educators generate and test hypotheses regarding how and why certain practices may or may not be working.

The IMS uses relational database technologies to maintain connections between and among the various information types. Thus, particular students and elements of curricula are linked to teachers via the sections they teach, and lesson plans link students with dates, times, teachers, and specific curriculum events, for example. Through ad hoc queries, practitioners are able to obtain reports on command and answers to their questions as these arise. Some typical questions are listed below.

Teacher Information.

- To what extent does the teacher's instruction contemplate the district or state scope and sequence recommendations and guide-lines?
- Does the teacher's instruction include a broad range of objectives covering basic as well as higher order statements of purpose?

- Do the evaluation methods used by the teacher align with instruction that is delivered, and does the teacher use a variety of methods to evaluate student performance?
- How is the teacher adjusting instruction by altering content or grouping strategies to match student characteristics and needs?

Student.

- Do instructional records indicate that students are being given opportunities to reinforce learning via remediation and/ or enrichment activities?
- Which components of the curriculum have been delivered to which students, by whom, how often and when?
- Is there evidence that evaluation methods reflect student capabilities?
- Are low SES students receiving the same quality of instruction as other students?

Curriculum.

- To what extent are core curricula (both scope and sequence) being included in classroom instruction?
- How much variety is there in instructional activities and resources which are available for inclusion in lesson plans?
- Which elements of the curricula are not being used by any teachers in their instruction?

Lesson Plans.

- Are cross references (e.g. state and local curriculum guide-lines) being integrated into lesson plans?
- Are students being evaluated on the instruction they are actually receiving?
- How do different teachers approach long-term instruction when addressing similar content?

Conclusion

In this paper it has been argued that IMS software is an essential element to be integrated into the conceptualisation, adoption and maintenance of any curricula we care to design and implement, allowing for stringent accountability criteria to be met in ways that do not remove the intrinsic satisfactions to be derived from teaching and learning in providing education for all students which can be justified on its own terms. From a vocational education point of view, within the perspective of the new curriculum orthodoxy, fundamental changes in the structures of schools and systems and the loosening of their constraints are essential to competitive success in a world economy.

Moving toward outcome-based curricula will help schools monitor their performance more effectively and thereby improve the quality of teaching and learning. Realising this vision is likely to place heavy demands on curriculum management and require the exercise of high quality leadership. This is supported by new information technology, which, when allied with human capacities and a vision of the future that we hold, can assist in the transformation of schools so that in information rich environments, when creating our future, the dimensions of change take on quite different meaning.

End Note.

(1) It is useful to distinguish between technology specifically designed for the task of education, and the use of technology to make education possible. See, for example, Scriven (1987) for an elaboration of these two different conceptions of technology.

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FIGURE 1: AN OVERVIEW OF STUDENT 'EXIT OUTCOMES' FOR THE NATIONAL PROFILE IN TECHNOLOGY - INFORMATION STRAND

Information Strand

	Nature	Techniques
At Level 1 the student	Identifies different ways information can be used and presented	Uses simple techniques to access, record and present information
At Level 2 the student	Describes different ways information is used, constructed, presented, stored and transmitted	Uses techniques to access, record, store, manipulate and transmit information and create information products
At Level 3 the student	Explains how information can be created, constructed, presented, stored and transmitted in different forms for particular audiences and users	Selects and uses techniques to manipulate, transmit and transform information when creating information products
At Level 4 the student	(a) Identifies the form, structure, style and presentation used in particular information products and processes (b) Describes how processing and transmitting information have evolved and are continuing to change	Selects and uses recognised procedures, conventions and languages to process information and create information products
At Level 5 the student	(a) Explains how forms, methods of transmission, standards and conventions affect the use and impact of information (b) Begins to consider issues of accuracy, privacy, global access and distribution	Manipulates, transforms and creates information, to achieve particular effects and meanings
At Level 6 the student	Explains how the form and structure of information products and processes are developed and can be influenced by particular cultural values and experiences	Creates, transforms and processes information using procedures, conventions and languages associated with particular information technologies
At Level 7 the student	Evaluates how regulations, statutory controls, conventions and information networks influence the form, structure and impact of information on communities and environments	Creates, transforms and processes information to meet detailed specifications using specialised techniques associated with particular information technologies
At Level 8 the student	Critically examines how style, form, source, transmission and medium influence: - access, validity and meaning of information - the impact of information on different societies and environments	Selects, develops and uses specialised techniques to produce information products and processes that approach commercial standards and meet specifications negotiated with clients or intended users.

FIGURE 2: A CURRICULUM INFORMATION MANAGEMENT PROCESS MODEL

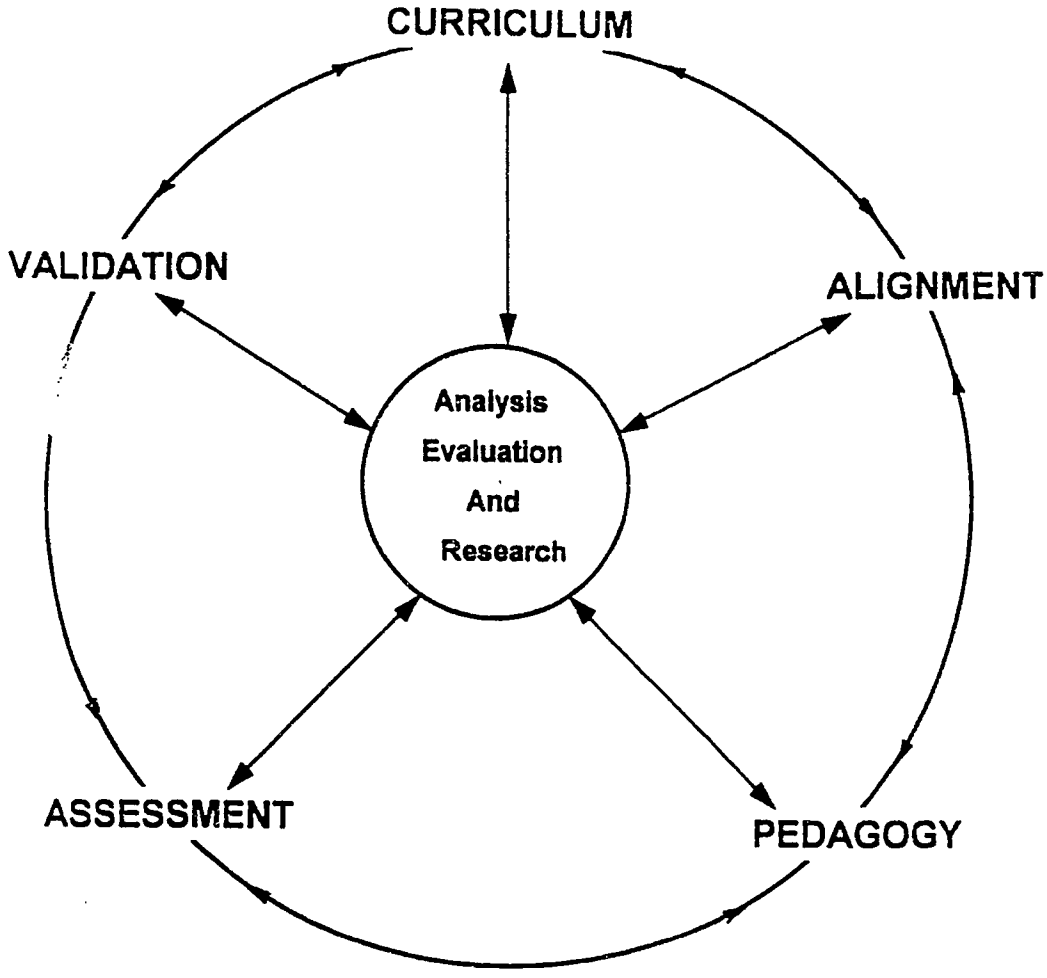
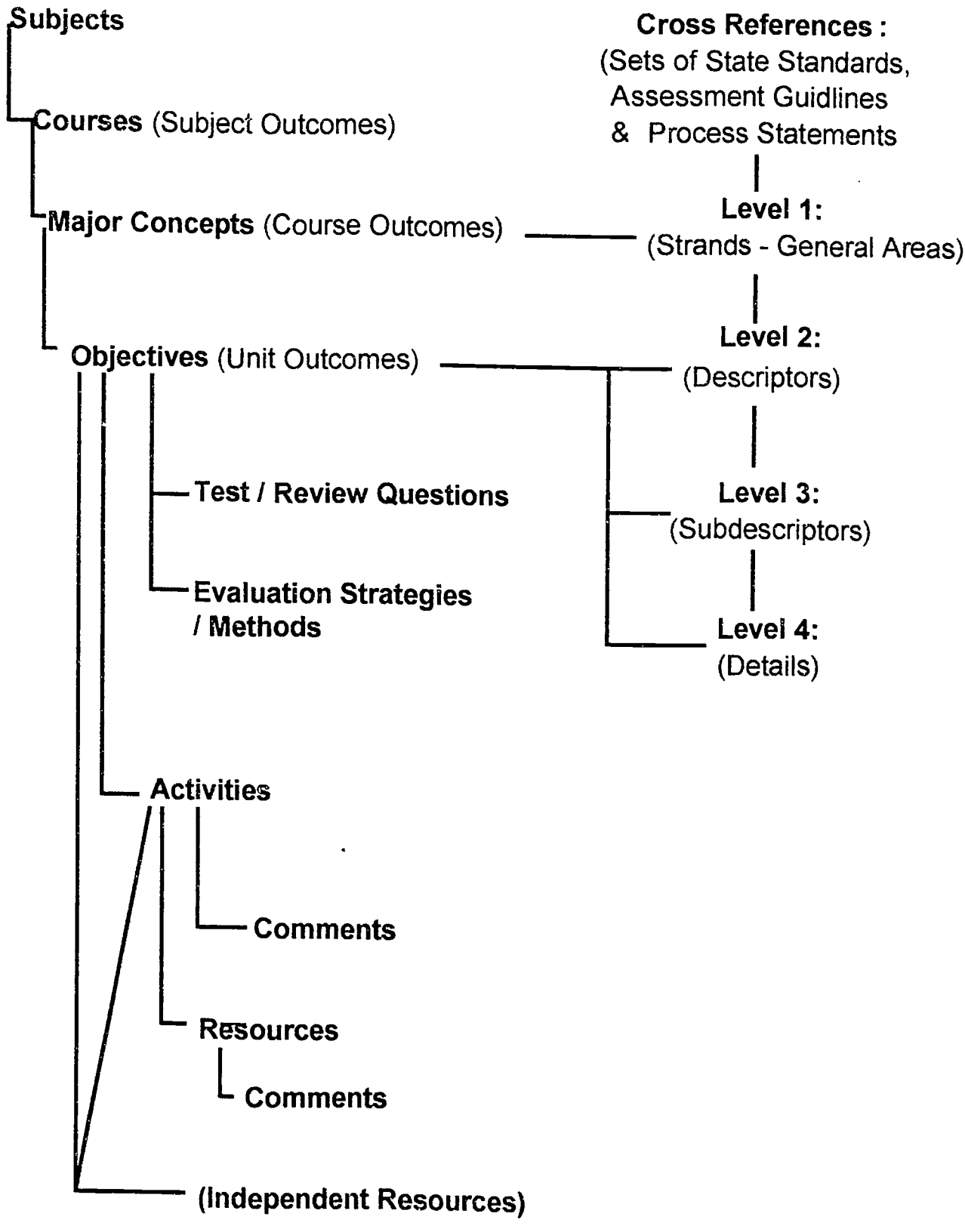

CURRICULUM
VALIDATION
ALIGNMENT
Analysis
Evaluation
And
Research
ASSESSMENT
PEDAGOGY

FIGURE 3: CURRICULUM DEVELOPER tm OUTCOMES-BASED EDUCATION PERSPECTIVE


Subjects
Courses (Subject Outcomes)
Major Concepts (Course Outcomes)
Objectives (Unit Outcomes)
Test / Review Questions
Evaluation Strategies / Methods
Activities
Comments
Resources
Comments
(Independent Resources)
Cross References :
(Sets of State Standards, Assessment Guidlines & Process Statements
Level 1:
(Strands - General Areas)
Level 2:
(Descriptors)
Level 3:
(Subdescriptors)
Level 4:
(Details)